EBSF, The European Bus System of the Future

Use Cases

Author

EBSF project partners in the framework of the activities of the Sub-Project 4 *"Validate, Evaluate, Disseminate and Exploit".*

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THE EBSF Use Cases

EBSF aims at developing a new generation of urban bus systems adapted to the specificities of the European cities; the project acts as a driver to increase the attractiveness and raise the image of the bus systems in urban and suburban areas, by means of developing new technologies on vehicles and infrastructures in combination with operational best practices.

EBSF does not look at the vehicle in isolation but as one of the elements integrated in the whole bus system together with infrastructure and operations; such logic, called "the system approach" is the methodology applied by the Consortium. This system approach reflects also the functional integration of the main bus system stakeholders: the organizing authorities and the municipalities; the operators and the bus manufacturing industry.

Main targets of EBSF

- Innovative bus system definition
- Breakthrough design of vehicles, infrastructures and operations
- Strengthened competitive position of the European bus manufacturers
- Boosting European research and development for urban bus networks
- Setting-up the frame for harmonisation and standardisation of the EBSF solutions

Test and evaluation

The innovations developed are tested by seven Use Cases in real operational scenarios in order to evaluate the added values of the new solutions vis-à-vis the existing status.

Each city is testing specific solutions to a specific problems:

Bremerhaven, Budapest, Brunoy, Gothenburg, Madrid, Rome and Rouen.

In 2012, at project completion, operators, public authorities and suppliers will receive guidance via a set of Recommendations on how to implement attractive and efficient bus systems that meet European requirements.

Budapest

Location
Hungary

Area
525 km²

Population
1 815 000 inhabitants
(20% of the population of the country)

Operator
BKV Zrt

Public transport users (per day)
4.8 million

Public bus users (per day)
2 million

Bus network
1 365 vehicles
204 bus lines (35 night lines)
3 809 bus stops

EBSF Testing period
March to December 2011

"High volume passengers flow"

In Budapest, urban buses are the daily choice of two million users amongst all modes provided by the public transport network (bus, tram, metro, suburban railway and trolleybus).

Increasing the flow of bus passengers, while improving comfort, space and security, is one of the challenges tested in the EBSF Use Case.

Another challenge is to improve efficiency in terms of operational costs while meeting environmental protection objectives.

Objectives

- Shorter journey time
- Passenger flow
- Safety
- Environment
- Remote maintenance

Technical characteristics

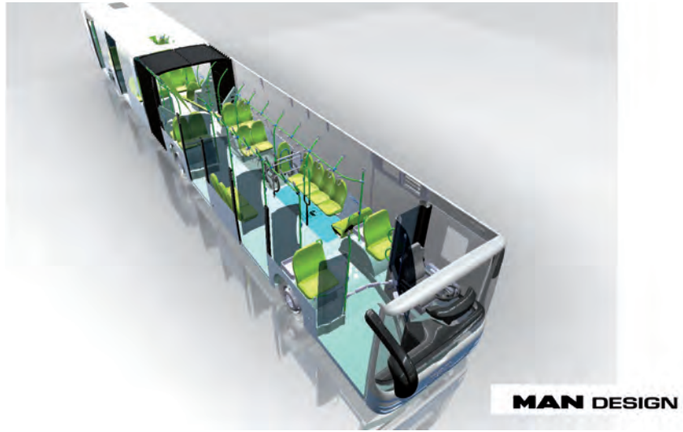
The bus demonstrator : 18,75 metre MAN Lion's City GL articulated bus

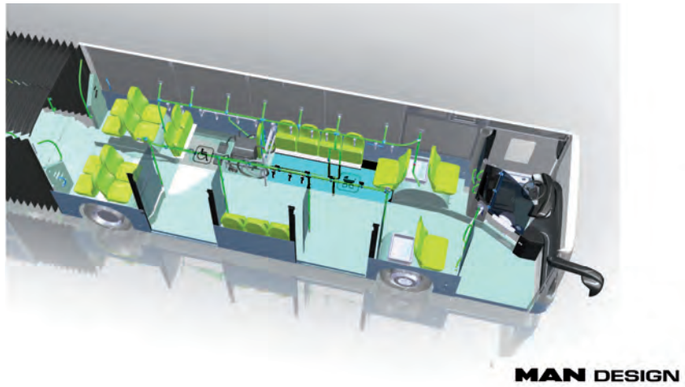
A new type of vehicle is being tested in real operational conditions: the MAN Lion's City GL, which is an innovative urban bus that offers passengers all kind of facilities to make journeys as enjoyable and comfortable as possible.

Five doors shorten the time spent at stops and offer better comfort and accessibility to passengers. The EBSF bus has been fitted with a new generation of doors for test purposes, equipped with an optimised, electrical drive mounted on the top of the rotating column. This saves space and does not need a complex mechanism, which saves weight and reduces maintenance effort. The new doors open and close quickly, reducing the time spent at stops.

passenger flow

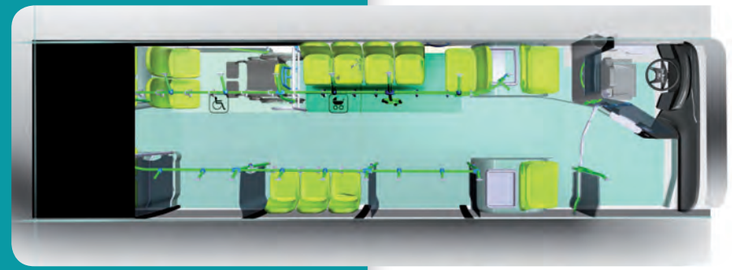
comfort and accessibility





With a 30% increase in standing places in the forebody the standard capacity is approximately increased by 10%.

- 39 seats (7 folding seats)
- 118 standing places



New interior design and flexible seat arrangements to optimise passenger flow.

The passenger compartment has been designed to allow the best possible passenger flow, flexibility and comfort. The design was based on scientific studies in the form of simulations carried out for this project.

- To provide extra seating, the driver is able to release seven electrically folding seats in the forebody.

The driver can block or release these seats at the touch of a button on the dashboard. This enables a generous amount of standing room to be made available for the efficient boarding and alighting of passengers at bus stops.

- An optical signal on the seat shows the passenger whether it is free or blocked.
- A sophisticated 3D counting system at the doors registers the passenger flow. This system is capable of distinguishing between children and adults.

Safety

Environmentally friendly

Safety optimised: specially conceived for large passenger volumes the bus is equipped with the most innovative systems to guarantee a safe trip to all, even when the capacity is at its maximum.

- Translucent folding bellows enable easy movement between the afterbody and forebody of the articulated bus and provide a pleasant and light atmosphere inside the vehicle.
- Conspicuous green uprights make it easier for passengers to hold on.
- Vertical light barriers show the entrance to avoid obstruction at doors.
- Video surveillance of the bus interior and at the doors.
- Fire extinguishing system in the engine compartment transmits emergency signals via the back office in the event of a fire and starts to extinguish the fire.

Environmentally friendly 320 HP six-cylinder diesel engine from MAN: the bus is powered by a modern engine reducing energy consumption. In terms of exhaust gases, it complies with the voluntary EEV standards (Enhanced Environmentally Friendly Vehicle), which set more demanding requirements for particulate emissions than the current Euro 5 emission standard.

Tele-diagnostic system

The system provides the data measured during service periods, and is available online, helping operators to reduce maintenance costs.

The EBSF IT platform provides standard interfaces for onboard IP telematic architecture, and standard rules for multi-channel communications between vehicle and infrastructure.

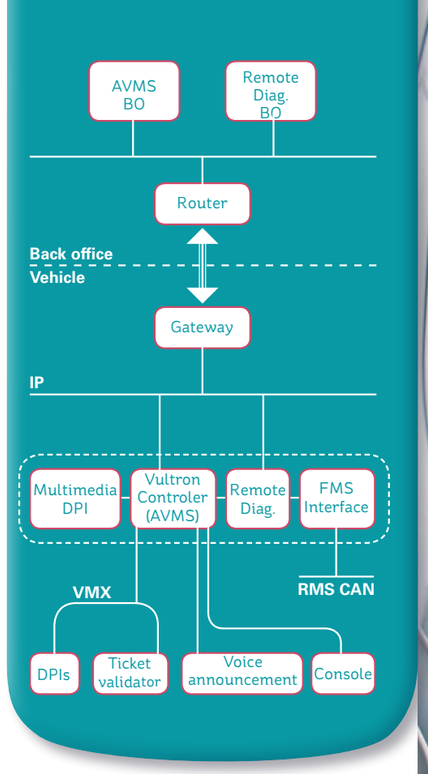
The use of the EBSF-defined standard communication protocol for on-board passenger information and remote diagnostics would allow the interconnection between IT devices of different manufacturers.

This flexibility responds to the needs of public transport operators and authorities by allowing the implementation of new functions and facilitating equipment / application renewal by maximising interoperability between heterogeneous systems.

Infrastructure

The EBSF bus line improvements contribute to the reduction of travelling time and dwell time at stops, and improve the punctuality of the service with :

- Dynamic Passenger Information boards at bus stops.
- Traffic light influence to offer priority to the bus.



Use Case impact

Testing the specially modified MAN Lion's City GL on Budapest's 11 kilometre inner-city route 86, a line with high-passenger volumes, is a great opportunity to test pioneering concepts in practice and to compare the results with the existing infrastructure.

The test phase delivers findings on the optimisation of the boarding, the passenger flow at bus stops is improved, time at stops is reduced and thereby the time required for each circuit of the route is decreased. Shorter journey times supported by traffic light influence increase the number of circuits per day and therefore optimize the passenger offer.

Madrid

City
Majadahonda
(Madrid periphery,
18 km from the centre of Madrid)

Location
Spain

Operator
Llorente

Connection to Madrid
6 interurban bus lines
30 buses

Bus passengers travelling to Madrid every day
30 000
(more than 50% of the total users
for the Majadahonda network)

EBSF Testing period
April to October 2011

"Multimodal and real time information"

Buses have become an inherent part of urban life. They have made most people's lives easier, particularly for those who need to be connected with big cities.

The Madrid Use Case looks at the metropolitan bus lines between the Majadahonda municipality and the city of Madrid. Majadahonda is a town located to the west of Madrid, 18 km from the capital's centre. It offers a comprehensive network of intercity buses that serve the capital and connect it with nearby municipalities. Many citizens who live in Majadahonda travel to Madrid every day, which causes high levels of congestion during peak times. On a working day 30 000 passengers travel by bus.

One of the main problems faced by passengers is the lack of information about the different options available to reach the capital as quickly as possible using public transport.

Between Madrid and Majadahonda, the EBSF project is piloting innovative, multimodal, real time information to provide users with more information via various means (web, SMS, displays, Bluetooth, etc.). Once the passengers know the waiting time or is aware of an incident in the transport system, they are able to decide what to do: whether to change mode or to use the waiting time for other activities.

Objectives

- Passenger information
- Advanced traffic management
- Real time multi modal information
- Underground location of vehicles

Technical characteristics

Integrated Public Transport Management Centre

The integrated real time information is the main objective of the Madrid UC. It allows the user to choose the best mode (bus, train or private vehicle) depending on the real network conditions.

Improving the information offered to the user by providing multimodal, real time, passenger information (including buses, trains and traffic) along the corridor, on board the vehicles, at stops and at interchange stations, via SMS messaging or via the web, Bluetooth, displays, etc.

- a passenger riding a bus approaching the railway station (just before entering the highway corridor) can choose either to get off and take the train—in case there is a problem in the high occupancy vehicle (HOV) lane, such as an accident or congestion — or to stay on the bus.
- a passenger on the train finds that there has been a breakdown on the track; he / she can change to take the bus.

With EBSF, the usual audio information (transmitted over speakers) is now complemented with panels and screens on board the buses and at the stops and stations.

Punctuality

"The EBSF Use Case in Madrid gathers all the information from all modes and shows it in an integrated manner, which facilitates the use of and access to public transport, and contributes to creating an integrated image of public transport."

Real time multimodal information already in operation in rail and metro networks, is made possible for buses thanks to another major innovation brought by EBSF: a new architecture able to manage the information coming from different operators / modes, communicating and integrating very different Automatic Vehicle Monitoring Systems (AVMS) — one for each operator — in the Integrated Public Transport Management.

Information integration at the back office level, including public transport information from interurban buses, regional trains, metro and light rail networks, multimodal interchange stations and road traffic information.

Service performance

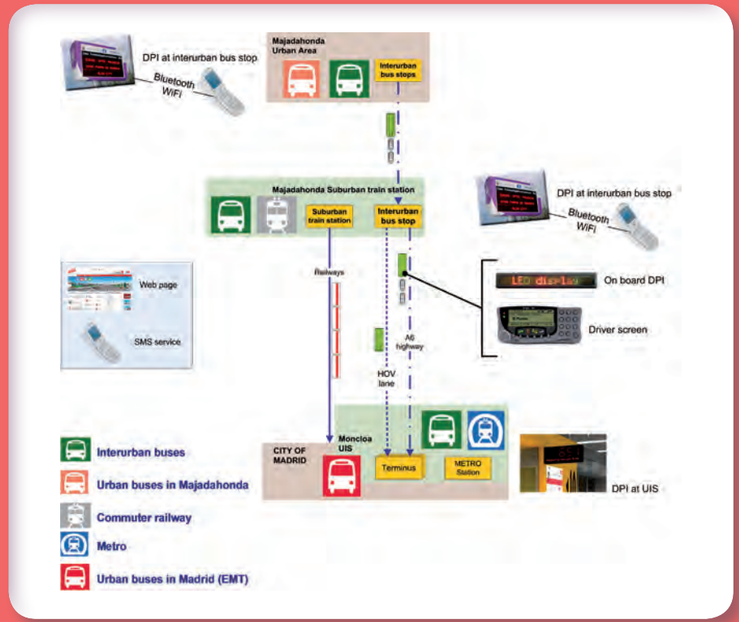
Reliability

Underground location of vehicles using radio frequency systems

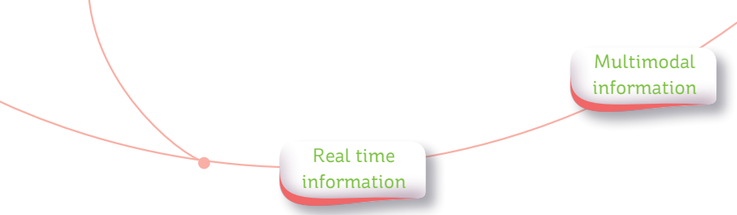
AVMSs (Automatic Vehicle Monitoring Systems) work fine in open spaces, but without GPS coverage underground, the operator loses the position of the buses in tunnels or, as in the case of Madrid, when buses enter underground interchange stations like the Moncloa station. Obviously, the operator needs to communicate with the bus in order to keep up with the operation management to send instructions (where it has to park, what bay has to be used, or a change in the route, etc.). This is now possible on the EBSF lines even when buses enter underground environments.

Radio frequency system (WiFi network, etc.) to ensure underground vehicle location.

Travel planner, web site and information phone number to inform passengers and to help them to connect to other public transport services.



"Providing the best mobility option to passengers"



Onboard Real Time Passenger Information (RTPI)

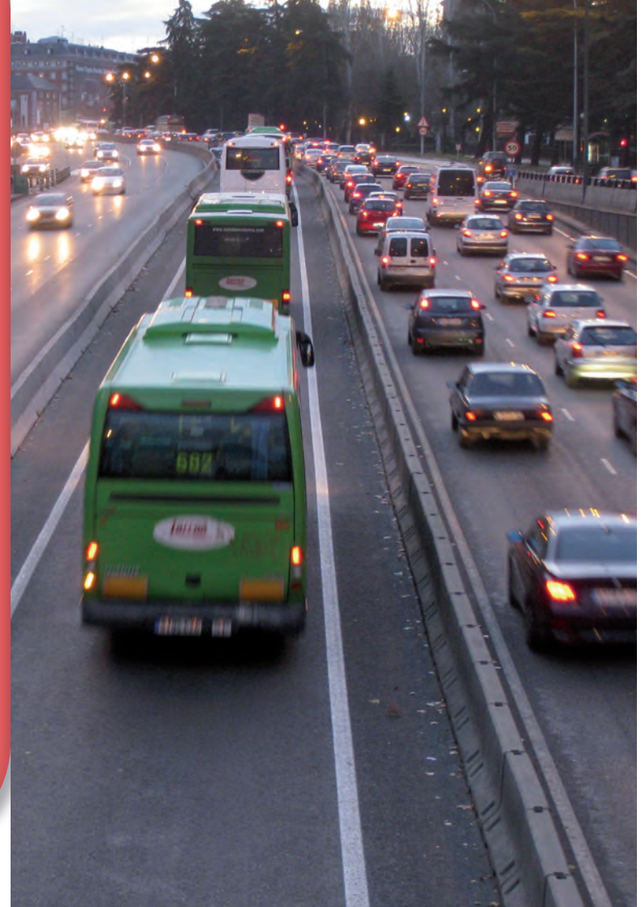
On estimated travel times and next train departures, considering road traffic:

- RTPI at a regional hub bus stop by the train station, providing information on next departures;
- RTPI at several stops in Majadahonda urban area through displays and Bluetooth;
- RTPI to bus drivers about next train departures, estimated time of arrival, road traffic incidents and interchange station incidents;
- RTPI through web page and SMS dispatched from the Integrated Public Transport Management Centre;
- RTPI at interchange stations, including next arrivals and departures, estimated travel times and road conditions and incidents.

EBSF Test

Six bus lines connect Majadahonda with Moncloa interchange: 651, 652, 653, 654 and 655 using the BUS-HOV system, and 651A, which does not use the BUS-HOV lane.

During the testing period, buses provided with AVMS systems run under normal operation conditions on lines 651, 651A, 652, 653 and 654. The 30 buses needed to provide the service during rush hour are equipped with such AVMS systems (22 buses are in operation, with 8 extra buses in order to keep up with maintenance activities and possible incidents).



Use Case impact

The main function of the Madrid Use Case is to provide multimodal real time passenger information (including for buses, trains and traffic) to allow the user to choose the best mode depending on the real situation of the network, encouraging the use of public transport. In addition, the modular AVMS system, which is connected to the Integrated Public Transport Management Centre, can coordinate services across all transport modes, managing incidents with operators and emergency services (fire brigades, ambulances, police etc.) in the whole region.

All improvements make the bus system more attractive, and the innovative infrastructure offers a new way of travelling adapted to passengers' needs. Tests carried out on lines with a high demand during rush hour will provide a good example for the rest of the regional network, where the same system will be applied. As a result, the high quality service and real time information offered throughout the public transport network in the region will promote a modal shift to public transport.

Rouen

Location
Normandy, France

Population
110 276 inhabitants

Operator
TCAR

Bus Network
27 lines (3 TEOR Lines)
220 buses
150 000 bus users per day

“Accessibilty for all passengers”

Buses have made most people’s lives easier. Unfortunately, a small percentage of the population is not fully catered to. Mobility challenged people still see buses as an obstacle to urban travel.

Although the TEOR system in Rouen already offers significant improvements in terms of accessibility thanks to the optical guidance system making it easier to align the bus at the station, a few more centimeters are needed to fill the gap completely, particularly for the vertical gap.

The EBSF innovations in Rouen are a further step forward to granting easy access to all, including those with special needs.

Accessibility is improved thanks to two innovative solutions completing the current optical guidance system and removing all gaps between vehicle and dock of station: a heigh regulation and a miniflap called “gap filler”.

Objectives

- Easy get in / get out for all passengers
- Accurate docking

Technical characteristics

The bus demonstrators

Two Irisbus Iveco Buses: one articulated Citelis and one articulated Agora, both with optical guidance system. In the framework of the EBSF these vehicles are equipped by two enhanced systems:

- a suspension electronic control for vertical gap filling
- a gap filler installation for horizontal gap filling

The new system enables simultaneously to bridge over the lateral and the vertical gaps between the bus and the dock, offering an optimized accessibility for every kind of passengers.

In this way, this enhanced solution reduces completely the step due to residual vertical gap and fill in fully the horizontal gap.

More generally the entrance and the flow of passengers is considerably improved, making the access in the bus more agreeable, and shortening the time at stops to offer a better comfort and a more efficient bus system.

Accessibility

Adjustable electric system

For height regulation and vertical gap filling (Agora and Citelis): the height regulation system detects the height of the dock thanks to electronic infrared cells placed on the side of the vehicle. The system regulates automatically the vehicle's height with an automatic suspension system and so places the bus at the same level than the dock.

This operation is realized automatically when the vehicle is approaching a bus station equipped with dedicated transponders based on RFID technology (Radio Frequency Identification). Moreover, the movements due to suspensions are similar to those produced by a conventional electronic suspension system.

"The step of passengers is reduced and the vehicle access is easier and comfortable".

EBSF Test

The test of the gap filler and the height regulation consists of three different phases:

- test at the workshop using simulation tools for the docking and tuning to the Rouen Use Case conditions;
- test in operation situation without passengers and finally in commercial;
- test in commercial operation on the Agora and Citelis vehicles deserving six specific stations equipped with RFID recognition system of the TEOR lines of Rouen.

High level of service

The EBSF bus demonstrators in Rouen are running on three TEOR lines, a **BRT network**, with dedicated corridors which is based on the east / west axle of the TCAR network. TEOR vehicles and stations are equipped with an optical guidance system to improve passengers' accessibility and comfort during docking phases. Furthermore, traffic light control gives priority to public transport vehicles.

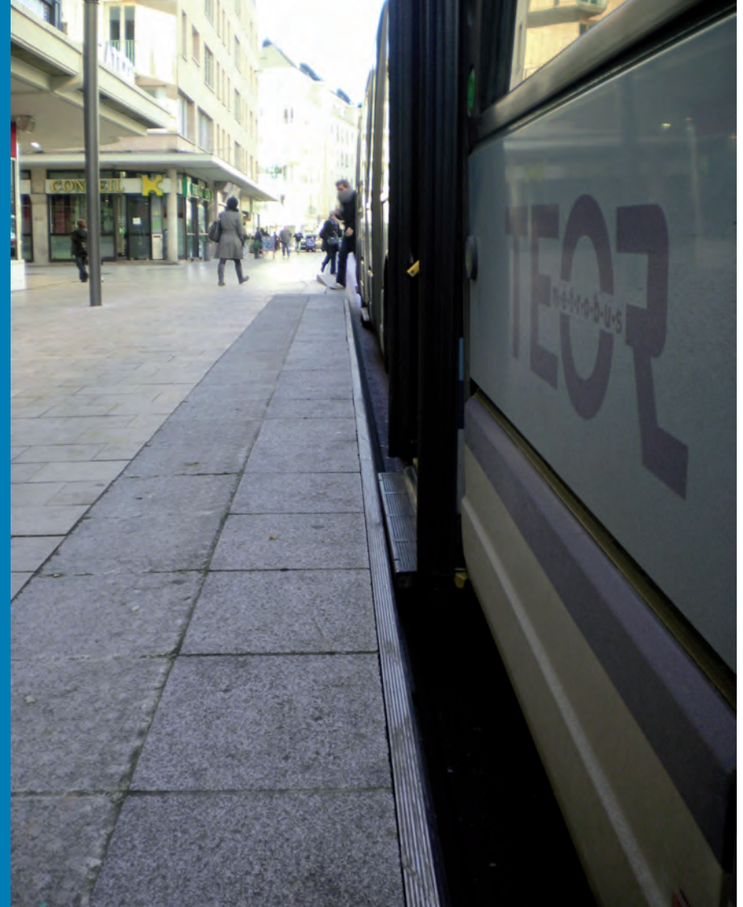
The gap filler

Between the bus and the dock for horizontal gap filling (Agora): the gap filler is a retractable step installed on the second door of an Agora bus.

The system is deployed automatically as soon as the door is open, and retracts once the door is completely closed. The platform is deployed and settled on the dock suppressing the horizontal gap, but only in station and with a vehicle speed zero.

The system is linked with a RFID recognition system of the dock for safety with RFID transponder installed in the ground just few meters before the station and RFID reader installed on the vehicle frame.

"This solution is safe because of the deployment effort of the device limited to a minimal value to avoid any injury to passengers."



Use Case impact

The aim of this Rouen Use Case is to enable a full accessibility for all citizens independently of their physical status. The gap filler and height regulation systems improve the accessibility to the bus which is an essential condition for users to choose the bus as the optimal transportation system.

Special consideration is given to the requirements of reduced mobility people including elderly people or parents with prams. The expected results are also to improve more generally the quality perception of passengers and potential users in promoting buses as an accessible mode of transportation for everyone.

Gothenburg

Location
Sweden

Population
508 714 inhabitants

Operator
Veolia and Göteborgs Spårvägar
on commission of Västtrafik AB

Public transport users (per day)
500 000

Public bus users (per day)
70 000

Bus network
40 articulated buses
20 bi-articulated buses
4 lines

EBSF Testing period
November 2011 to January 2012

"Central driver cabin"

Over the past years, bus lines have been gaining in popularity in Gothenburg. This positive result for buses, but also for the whole public transport network, is the consequence of great efforts to respond better to users' needs. The implementation of the "Trunk Bus System" in which EBSF participates through the Use Case of Gothenburg is taking part in this new wave of interest in public transport.

The "Trunk Bus System", based on the tram mode, provides buses with: dedicated lanes, boarding through all doors, high standard bus stops, real time information and ease fare payment.

The EBSF Use Case focuses on improving services and access. Special consideration is given to the requirements of people with limited mobility and sensory ability, senior citizens and women and children.

Objectives

- New place for the driver
- Passenger accessibility
- Commercial speed

Passengers flow

Accessibility

UC Technical characteristics

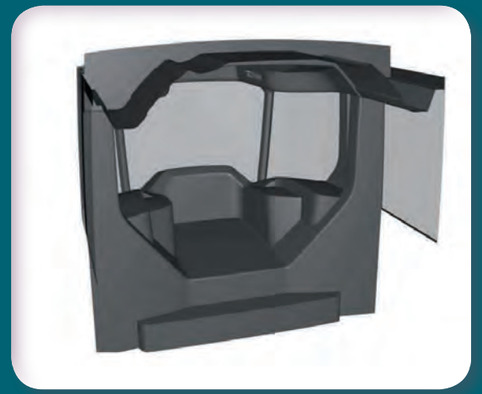
The EBSF Volvo demonstrator

A bus with a centred driver's cabin having the first door behind the front wheels and a new internal layout.

Following the example of the trams, the EBSF Volvo demonstrator bus has developed a new central driver cabin by placing the front wheels in the front corners of the bus and positioning the driver between them in the centre. Drivers thus feel safer and have a better view of the traffic situation.

- By putting the wheels in the front next to the driver, there are more possibilities for the interior layout of the bus.
- With the absence of the wheelhouse between the first and second doors wheelchairs access in the front door is improved.
- The passenger flow inside and outside the bus is enhanced thanks to the double doors with large door blades.
- The semi-transparent articulation bellow ensures a high level of comfort inside the bus to make journeys more pleasant for passengers.

Front with short overhang



Drivers area

Dwell time at stops

Driver safety

Driver visibility

- More space is dedicated to standing passengers and the folding seats can be blocked or released according to the passenger flow. This together with higher accessibility is reducing the dwell time at stops

In order to improve and test different options of internal layout deriving from the new driver workplace positioning, a software simulator has been developed as part of the EBSF project. This tool can be used to design the passenger compartment on the basis of the results provided by scientific simulations reproducing the movements of the passengers inside the vehicle as well as their access or exit. The study carried out by the University of Chalmers identifies all typologies of passengers and pays also attention to the living place of these people.

"With a new external front design the image of the vehicle gains in modernity and attractiveness"

Drivers' training to improve passengers' accessibility on the bus route 16

Along the Use Case line a curved 17 cm high curb stone is used on all bus stops. This in order to make the gap between the platform and bus floor as small as possible. The curved lower part of the curb stone gives the driver the possibility of putting the wheels against the stone without damaging the wheels or the tires.

In theory, this means the gap horizontally should be close to none. In practice many

Commercial speed

© GTZ - Andrea Broaddus

drivers do not take advantage of it, with a loss of quality for the passengers. By adding road markings as a visual guidance, we will help he driver find the best way to approach the stop.

The EBSF drivers' training in Gothenburg is carried out on route 16 where the ordinary buses are the 24 meter long bi-articulated Volvo buses.

By learning how to better use the existing infrastructure, training is expected to:

- Reduce the dwell time at stops: by knowing what to do when docking to the stop, drivers will have more confidence and driving will be smoother before and after stops.
- Raise the commercial speed of the bus routes: the reduced time at stops will make it possible to keep to the timetable, including time at end stations.
- Better accessibility for all users, but especially disabled people: the smaller gap between the platform and the bus makes it easier for all passengers to board the bus, especially for anyone who uses a wheelchair or has problems with their sight and parents with prams. This will have a great impact on accessibility.

Use Case impact

Passenger and driver well-being is central to the Use Case of Gothenburg. The EBSF Volvo demonstrator bus, with a centred driver workplace offers new internal layout possibilities boosting the comfort of passengers, improving the accessibility of all and reducing dwell time at stops. Drivers feel safer and have a better view of the traffic situation.

The training of drivers will show what can be achieved by adapting knowledge and skills to existing infrastructure.

Bremerhaven

Location
Germany

Population
114 840 inhabitants
Tourism (visits / overnight stays)
2 011 Mio / 407 730 (2010)

Operator
Bremerhaven Bus

Public bus users
13.59 Mio/year

Bus network
69 vehicles
(56 articulated / 13 standards)
16 lines

EBSF Testing period
April to December 2011

"Better e-public services"

Public transport is in the frontline when speaking about the consequences of demographic and climate changes (population getting older, effects of traffic congestion, etc.). Urban bus systems must therefore be prepared to offer new solutions and services in terms of accessibility, information tools, comfort, etc. Multiple public transport information and links to public communication services can help to overcome the "information barrier" to using public transport and provide more effective marketing tools to provide:

- seamless journeys' with a high level of on-board comfort and safety, attractiveness, in time operation and consistent level of information service;
- better e-public services through dedicated IT systems on-board and at selected bus stops.

Objectives

- Seamless journey
- High level of e-public services
- Public perception

Technical characteristics

The EBSF EvoBus demonstrator bus and the retrofitted buses

- Based on the Mercedes-Benz Citaro G City Bus, the EBSF demonstrator vehicle is an innovative urban bus thanks to new passenger information and communication system technologies with visual interior and exterior elements.
- Illuminated coloured (green / red) door frames (LED chains) light up when the bus approaches the bus stop and indicates to passengers at which door they can board the vehicle.
- A seat occupancy system is introduced in the rear part of the bus which uses coloured lights in the roof panelling above the seats to display whether a seat is occupied (green lamp) or vacant (red lamp).

"Passenger access to the vehicle is better controlled and passenger flow is improved less time spent looking for a vacant seat."

EBSF Test

About 56% of the population is living along the Use Case line (N° 502). This line connects densely populated districts in the outskirts of the city, the main tourist attraction area "Havenwelten", the city centre and the main station .

The test phase extends the information offer:

- from any place in the city (home, re-designed bus stop, vehicle, public space) ;
- to other means of transport (e.g. regional trains) ;
- and to other online information sources (e.g. e-public and tourism services).

The aim is to enhance public perception of the bus transport system among those who are not users (citizens, tourists, etc.).

Information quality

Comfort

On-board services

public perception

For a better internal comfort, the demonstrator bus is also equipped with:

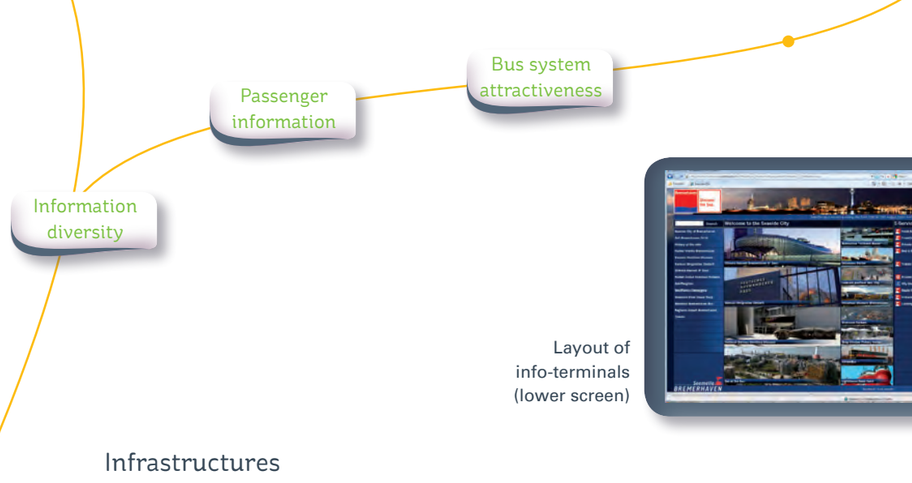
- two 230V sockets to connect laptops or charge mobile phone batteries;
- leaning surfaces and folding seats in the two standing platform areas;
- WLAN router to ensure free access to the internet.
- a GPS amplifier to allow passengers to localise the bus through their mobile phone application;
- high-end vehicle amplifier automatically adapting the announcement through the interior loudspeakers to the ambient noise level.

IT and Communication Systems

The EvoBus demonstrator bus and the retrofitted vehicles are equipped with a driver terminal and on-board AVMS (ITCS) computer dynamic passenger information components for visible passenger information: announcement system and TFT passenger information screens (two 20" in each of the 15 retrofitted buses and four 19" in the demonstrator bus).

Real time interchange information is displayed on screens allowing passengers to see, for example, the real departure time from the next bus stops, interruptions to services, alternative routes, tourist and public service related information (events, city council announcements, etc.), weather, news and so on. In the retrofitted buses the same information is shown on the infotainment screens.

All buses communicate with the central application via data radio (to get updated operation data) parts of it via UMTS / GPRS and WLAN. The communication protocols between these components are based on the technical specifications developed in the EBSF research activities (on-board AVMS services and MADT (display) services).



Layout of info-terminals (lower screen)

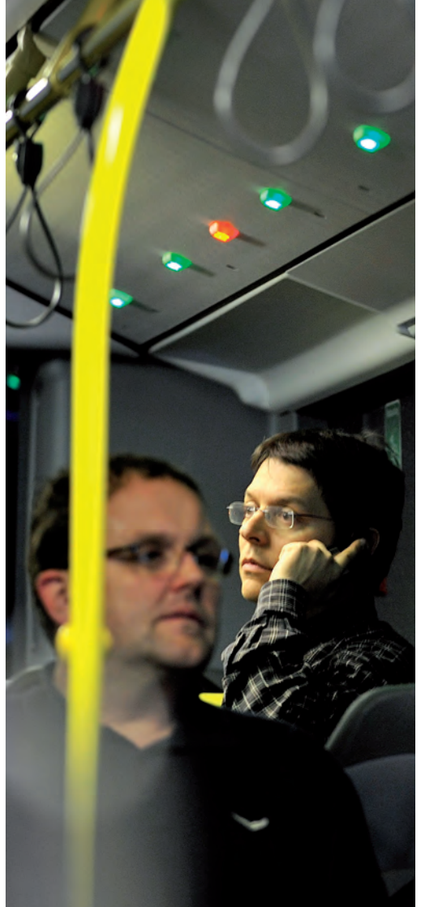
Infrastructures

The infrastructure focuses on redesigned bus stops along the Use Case line 502.

Ten bus stops strategically situated in Bremerhaven (e.g. tourist attraction area "Havenwelten", city centre, main station, public buildings) are improved with new info-terminals displaying public transport and public service related information services constantly updated throughout the day. These info-terminals are a further development on existing ones, as they now offer 22' wide screen displays (format 16/9) and additional communication features (Bluetooth, WLAN).

Four bus stops offers two screens: the upper screen displays the departure time of the buses and the lower screen (just as for the other six info-terminals) gives access to online public transport information (e.g. timetable, status of train services connections) and other online information sources (tourist and event information, route planner, e-public services, authority announcements, bus timetable, etc.).

The new design and layout of the EBSF info-terminals improve the quality of the service in terms of visual / non-visual (spoken) information through better visibility (e.g. backlighted TFT screens, micro non-reflecting protective glass, displayed information (text, images) rich in contrast, protection against solar reflection), arrangement of control elements (keyboard, trackball) and possibility to download specific contents as video, audio, image or text file via Bluetooth (tested at one site only).



Use Case impact

Bremerhaven offers ideal conditions for testing new features and services of a modular advanced passenger information system in practical operations. Indeed, as a medium-sized city, Bremerhaven faces the challenges of urban regeneration (adapting to demographic and climate change) that call for strengthening the role of public transport. Furthermore, the city welcomes many tourists everyday on public transport.

The test phase extends the information offer from any place in the city (home, redesigned bus stop, vehicle, public space), to other means of transport (e.g. regional trains) and to other online information sources (e.g. e-public and tourism services). The aim is to enhance public perception of the bus transport system among those who are not users (citizens, tourists, etc.).

The EBSF innovations in the EvoBus demonstrator bus facilitate passengers' journeys and in the redesigned bus stops, waiting time does not act as a barrier to choosing the bus as a transportation mode. The new solutions boost the quality level of the bus service for all passengers, in particular for visually and hearing impaired people.

Brunoy

Location
France 25 km from Paris

Population
190 000 inhabitants
served by the network

Operator
STRAV

Bus Network
150 vehicles
22 lines

Features of J line
38 stations
17 000 bus passengers / day

EBSF testing period
March 2011 to June 2012

"Telediagnostic and remote maintenance system"

Today, the activities of a bus workshop related to vehicle maintenance are mainly divided into two parts:

- periodic activities: technical controls, fluids change, etc;
- corrective activities: fixing of vehicle failures.

For a public transport fleet operator, the main maintenance issues are linked to the technical failures which appear on line during vehicle service.

This type of failure has an impact on the service quality and on operation costs :

- for the passenger: change of vehicle during the trip and delay;
- for the operator: replacement of the vehicle during operation, immobilising and repair of failing vehicle.

In Brunoy, the EBSF Use Case tests a new telediagnostic and remote maintenance system based on new information and communication technologies.

Objectives

- **Preventive maintenance**
  to limit consequences due to technical failures
- **Predictive maintenance**
  to anticipate critical technical failures before vehicle immobilisation;
  to reduce the number of technical failures during service.

Vehicles availability

Service reliability

Service quality perception

"The optimisation of maintenance activities is expected to reduce operation costs, improve service performance and quality perception. It also improves safety and drivers' confidence in the vehicle".

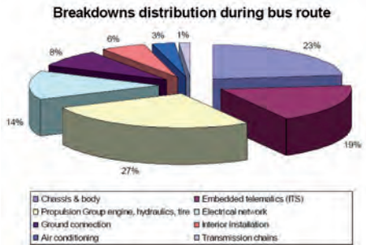
Technical characteristics

Ten CITELIS Euro IV vehicles from bus manufacturer IRISBUS have been equipped with a new embedded system based on an innovative technical architecture, allowing some information to be extracted from vehicles' subsystems.

Step 1: The onboard phase, when data collection takes place

Vehicles have been equipped to collect three sources of vehicle data:

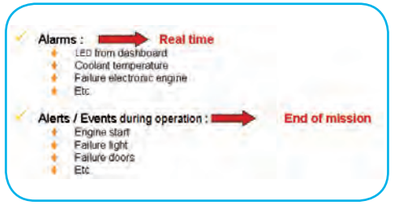
- Multiplex network for vehicle alarms and alerts including dashboard lights;
- Control Area Network (CAN) through the standard interface Bus-FMS2 data;
- Additional specific sensors for three key components, the doors, battery and brake system. These sensors are used to monitor in detail the evolution of key data.



Anticipate interventions

Limit vehicle break downs

Reduce the time and cost of interventions



Two communications channels are used to download data to the workshop, depending on their type, priority and critical levels:

- Long-range communication channel: GPRS for critical data like red alarms. Data are downloaded in real time when a red alarm appears;
- Short-range communication channel; WiFi for blackbox data coming from specific sensors and other alerts which are not critical. Data are downloaded when the vehicle comes back to the depot.

Telediagnostic data is classified by type, priority and critical levels

Step 2: The back-office phase involving predictive diagnostics.

Once the data are collected, all information is transmitted to the workshop, where it is analysed using specialised advanced algorithms.

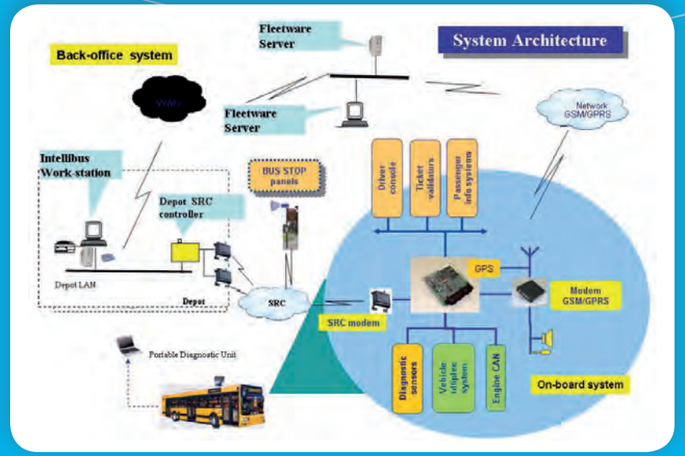
Data is available for consultation on a website and can be requested according to different parameters (bus number, time period, type of alert, etc).

Moreover, alarms, alerts and events are associated with a map, which allows events to be correlated with the line.

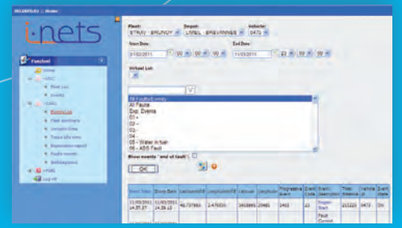
Specific software related to the three key components (doors, brake system and battery) is being developed for predictive maintenance purposes. The objective is to anticipate the technical failures and associated serious fallouts like technical failures during the service. This specific software is

EBSF Test

The experiment takes place on the line J, which is the main line of the STRAV network, in the commune of Brunoy. The line connects passengers to RER A and RER D, which are main public transport train lines, taking them to Paris. This line has also a specific topographical profile (slopes) and is subject to important traffic conditions. It provides a huge range of operation conditions in particular for the three key components monitored by the telediagnostic and predictive maintenance system .



Telediagnostic system architecture



Telediagnostic data available for consultation on a website

Telediagnostic data requested on a map

The reduction of operating costs is a key concern for public transport operators and authorities that needs to be tackled without compromising service quality. The primary strategies to be considered to achieve this goal are:

- improvement of maintenance processes (which also impacts on the overall reliability of the service);
- focus on life cycle cost including investment cost, maintenance cost and operating costs;
- standardisation and adoption of common approaches and solutions which could be applied across a heterogeneous vehicle fleet (different age, brand & model) without adaptation and specific developments.

based on advanced algorithms developed using data fusion, sampling and signal processing.

The global technical architecture of the telediagnostic system tested in the Brunoy Use Case is integrated and compliant with the EBSF telematic architecture which has been developed by twenty-two partners of the project and has been validated on a testbench. This architecture is based on existing standards at interface and communication protocol levels.

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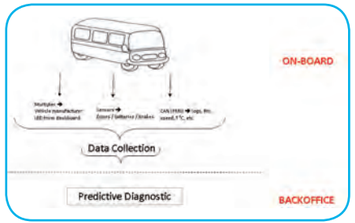


Telediagnostic system

Use Case impact

The Brunoy Use Case impacts on the:

- reduction of number of reserved vehicles;
- immobilisation of vehicles for maintenance actions;
- reduction of technical failures during operation service.

Advanced data analyses enable monitoring of all events and problems affecting vehicles with automatic processes, and therefore allow the implementation of efficient and optimised preventive and predictive maintenance applications, which could be integrated into the telediagnostic system. These analyses improve the reliability of vehicle maintenance.

Finally, the compliant architecture of the telediagnostic solution with the standard telematic EBSF testbench provides a solution which can be included in integrated architectures and allows it to be part of the system overview.

The test phase will deliver results on the optimisation of operating costs. And all the improvements of these EBSF innovations on telediagnostic and remote maintenance systems will in turn optimise service quality perception.

Rome

Location
Italy

Population
4 million inhabitants

Operator
ATAC

Public bus users
605 million

Bus Network
2764 vehicles
274 lines

EBSF testing period
September 2010 to August 2011.

"Flexible internal layout"

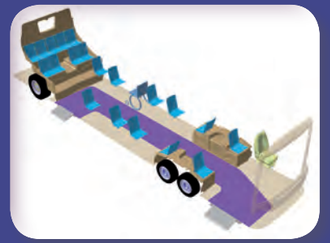
Uncontrolled urban growth, un-followed by adequate transport services, unbalanced transport demand and supply, personal security and comfort perceived on the bus, social perception and many other "barriers" determined in the recent years a dramatic modal split in favor of private vehicles.

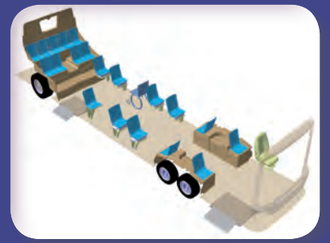
Nowadays in the city of Rome there are more than 2 million cars. Pedestrian and public transport's shares are only 20% each of the total mobility, while 60% of the trips are covered by private transport.

The increasing of private mobility in the metropolitan area has caused a quick and wide decreasing of the quality of life in the whole city. The EBSF Use Case in Rome is developing innovations aiming at improving mobility to modify modal split in favor of public transport.

Objectives

- Service efficiency
- Maintenance costs
- Operational costs





"Adapting the number of seats available to passengers depending on the effective passenger's flow"

Technical characteristics

Internal layout / modularity on Irisbus bus demonstrator

The EBSF bus demonstrator is based on the Hynovis concept bus developed by Irisbus Iveco. This bus already offers a very innovative passenger compartment providing comfort and well being to passengers:

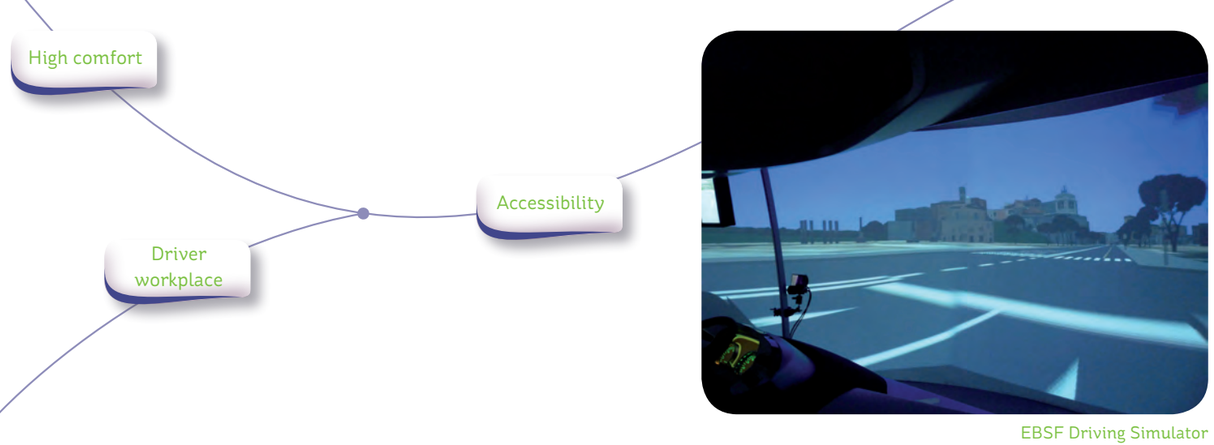
- easy access to the seats: no steps of the first 10 meters of the bus (out of 12);
- a central aisle brought to 1,2 m (instead of 0,9 m) to ease the passenger movement inside the vehicle;
- a glazed surfaced increased by 20 %, to open the vehicle on the city and to bring light into the vehicle;

A new modular layout of seats has been developed by the EBSF project to enable to adjust the capacity of the vehicle to the needs, and to optimize the amount of seats and the comfort offered to the passengers.

The system consists in a **sliding seat**, aligning the two seats to the same level for a better confort.

The seats arrangement is made by the driver itself, depending of the affluence during the day. This arrangement can be done at the terminal station. The process can be manual or fully automatic.

The EBSF tests will allow verifying for different **combinations of seat arrangements**, what is the limit number of passengers allowing the correct flow in bus operations. In addition to a higher comfort for the users, the accessibility to the vehicle will be improved thanks to a better passengers' flow and operational costs through bigger capacity of buses during peak hours should be improved.



EBSF Driving Simulator

The Driver Workplace

The improvement of work conditions for driver is a key issue for better service, performance and industrial relations between company and employees. The driver's cabin is the place where the driver spends 6 to 8 hours of his life every day, and for this reason it has to be comfortable, ergonomic, safe and should assure the best microclimatic conditions. Nowadays in Europe, the cabin guide is extremely not homogenous, due to the lack of official EU standards and to the extremely variable typology of buses.

Based on the real needs of the drivers, the new EBSF driver workplace improves security and safety and lead to a simpler and more intuitive driving style. Ergonomics of the workplace space, usability and friendliness have been improved, in accordance with the requirements from the major stakeholders, like operators, manufacturers, authorities.

A static mock-up of a future European driver's workplace has been especially produced for tests in the driving simulator at the IVI-Fraunhofer Gesellschaft in Dresden (Germany). The ergonomic quality of the mock up in the driving simulator (reproducing two bus lines in Rome and Dresden) is being tested by drivers of different European cities (Dresden, Gothenburg and Rome).

EBSF Drivier Workplace

Remote maintenance

Improving Remote Maintenance is a key issue to ensure a better quality of the vehicles fleet, to significantly decrease the maintenance and the operating costs, and to offer more performing and reliable service. In Rome, EBSF focuses on the maintenance needs of the methane buses exploited by ATAC; needs which are different from the maintenance requirements for diesel or electric buses.

In the frame of EBSF, 50 existing IRISBUS CNG buses are equipped with a new diagnostic on-board system (DIGIGROUP i-Diag system).

Improvements of the new EBSF Driver Workplace

Drivers' comfort

- New ergonomics to reduce fatigue and facilitate access to controls
- Seat design adapted to varying drivers' morphologies
- Seat highly protected against vibrations
- High acoustic and microclimatic comfort conditions

Drivers 'safety

- Wide open view of the surroundings thanks to the new design of the cabin
- Comfortable and ergonomic cabin access with modular upgrade (cabin door with safety window or closed cabin) which enables a high driver security

Better service performance

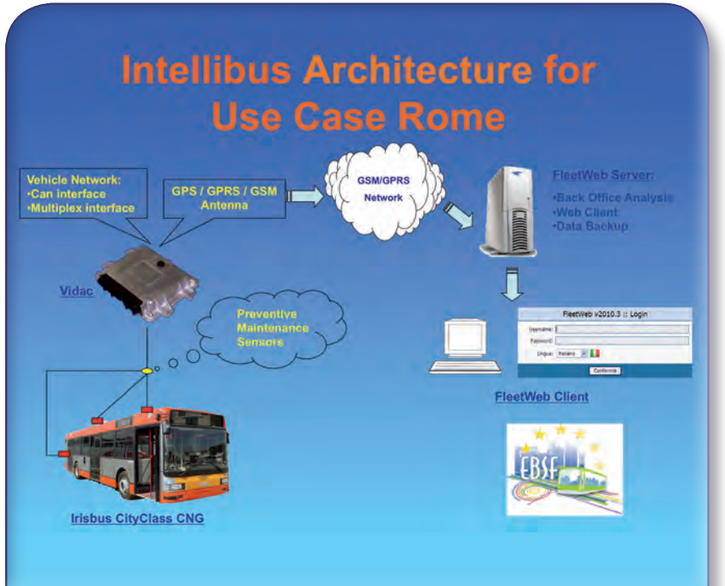
- Driver's console informs about the state of the bus and any malfunction Cabin design to enable drivers to give information to passengers, to welcome them aboard and to easily sell them tickets.

Maintenance costs

Service efficiency

Operational costs

The on-board device will collect vehicle's information from specifically installed sensors and bus Control Area Network (CAN). These collected data will be sent to the back-office application by the GPRS network. ATAC Maintenance Engineers will adapt the maintenance program for each vehicle on the basis of the real life and stress of the vehicle, by means of collected data analysis.



Use Case impact

The smart internal layout modularity of the EBSF Demonstrator enhances the level of the bus service, in particular in peak hour conditions: the new solutions avoiding big affluence to harm the comfort of the passengers'.

Drivers' needs are better answered through the joint work of the partners to imagine and create a common driver workplace offering the highest level of security, safety and comfort.

Innovations on remote maintenance system will impact positively on the general fleet of the vehicle, on the service reliability as well as on the maintenance and operating costs for the operator.

Intelligent, Innovative, Integrated

The European Bus System of the Future is

An intelligent system ...

- efficient use of information
- different bus system solutions adapted to specific needs of all stakeholders

... with innovative vehicles and infrastructures ...

- improved comfort to drivers and passengers
- improved accessibility to all the users
- smart use of energy

... integrated in the European urban scenarios

- adapted to different modern and historical city contexts
- taking into account the future mobility trends
- new services for passengers and operators
- core part of the whole transport network for citizens seamless mobility

EBSF is an initiative of the European Commission under the Seventh Framework Programme for Research and Technological Development. Starting in September 2008; EBSF is a four-year project with an overall budget of 26 million Euros (16 millions co-funded) and is coordinated by UITP, the International Association of Public Transport.

For the first time, EBSF brings together the five leading European bus manufacturers and forty-two other partners in 11 EU countries:

- European bus manufacturers

Evobus / Mercedes, Iveco Irisbus, MAN, Scania, Volvo

- Public authorities

Vasttraffik Gothenburg, Nantes Metropole, Consorcio Regional de Transportes Madrid, BIS Bremerhaven

- Public Transport operators and national public transport associations

RATP, ATAC Rome, Veolia, TEC, Bremerhaven Bus, ATV Verona, ATM Milan, RATB, BKV, VDV, ASSTRA, UTP

- The supply industry

Hübner, Init, Digigroup, Ineo, Pilotfish, Actia, Hogia, Vultron, Tekia

- Research / consultancy

D'Appolonia, Berends, CERTU, Chalmers, CEIT, Fraunhofer, Transyt, FIT, Newcastle University, PE International, INRETS, University of Rome 3, University of Rome / DICEA, TIS, CRF

UITP, the International Association of Public Transport (UITP) represents 3,400 members from 92 countries.

www.ebsf.eu

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